EXCERPTS FROM REMARKS PREPARED FOR DELIVERY:

FIFTH ANNUAL NASA/CONTRACTORS CONFERENCE

WESTLAKE, OHIO; OCTOBER 12, 1988

DALE MYERS

DEPUTY ADMINISTRATOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Excerpts from remarks prepared for delivery; Fifth Annual NASA/Contractors Conference; Westlake, Ohio; October 12, 1988.

GOOD MORNING, LADIES AND GENTLEMEN, AND LET ME ADD MY PERSONAL WELCOME TO JOHN'S. THE FACT THAT SO MANY OF YOU ARE HERE, AND AT THIS EARLY HOUR, IS AN ENCOURAGING INDICATION OF YOUR CONTINUING INTEREST IN AND DEDICATION TO THE THEME OF THIS CONFERENCE--"QUALITY--A COMMITMENT TO THE FUTURE". FOR MANY OF YOU, THIS WILL BE THE FIFTH YEAR OF ATTENDANCE AT THESE CONFERENCES DEDICATED TO THE ACHIEVEMENT AND MAINTENANCE OF QUALITY, PRODUCTIVITIY, AND EXCELLENCE OF WORKMANSHIP IN OUR JOINT BUSINESS/GOVERNMENT AEROSPACE ENDEAVORS.

I THINK IT IS SAFE TO SAY THAT IN THOSE FIVE YEARS WE HAVE MADE MAJOR PROGRESS TOWARD OUR COMMON GOALS. AND, OF EQUAL IMPORTANCE, IT SEEMS WE HAVE STARTED SOMETHING TOGETHER, SOMETHING VITAL AND CONSTRUCTIVE THAT NEEDED STARTING. WE HAVE AWAKENED A NATIONAL INTEREST IN THE IMPORTANCE OF HIGH QUALITY AND PRODUCTIVITY IN ALL THE WORK WE DO AS A NATION IF WE ARE TO COMPETE SUCCESSFULLY IN THE INCREASINGLY CROWDED AND COMPETITIVE WORLD MARKET.

SINCE THE FIRST NASA/CONTRACTORS CONFERENCE BACK IN 1983, CONFERENCES LIKE OURS, CONCENTRATING ON WAYS TO PROMOTE RELIABILITY, SAFETY, MAINTAINABILITY, QUALITY ASSURANCE, AND COMPETITIVENESS, HAVE PROLIFERATED LIKE FRUIT FLIES-- A MOST HEALTHY AND BENEFICIAL TREND FOR OUR COUNTRY, AND ONE FOR WHICH YOU HERE IN THIS ROOM AND YOUR PEERS AND ASSOCIATES ARE TO BE CONGRATULATED.

AS YOU KNOW, WE HAVE RECENTLY HAD A 100% SUCCESSFUL MISSION WITH THE ORBITER DISCOVERY, PROVING OUT BEFORE THE WORLD THE EFFECTIVENESS OF THE REDESIGNED AND IMPROVED SPACE TRANSPORTATION SYSTEM, AND PUTTING US ON THE MOVE AGAIN IN SPACE. THAT SUCCESS WAS THE RESULT OF A DEVELOPMENT PROGRAM LASTING SOME TWO AND A HALF YEARS AND INCORPORATING LARGE DOSAGES OF JUST THE KIND OF THINGS WE ARE HERE TO DISCUSS--HIGH QUALITY PERFORMANCE, EXCELLENCE OF WORKMANSHIP AND SUSTAINED PRODUCTIVITY.

A CLASSIC EXAMPLE OF THE KIND OF THING THAT CAN HAPPEN IN A PROGRAM SUCH AS THAT ONE IS THE VEXATIOUS LITTLE LEAK IN THE PIPING FOR THE ORBITAL MANUEVERING SYSTEM. THE SMALL PROPELLANT LEAK WAS NOT DISCOVERED UNTIL THE ENTIRE SHUTTLE STACK WAS OUT ON THE LAUNCH PAD. IT WAS IN A MADDENINGLY INACCESSIBLE LOCATION IN THE OMS POD, AND IT LOOKED FOR A WHILE AS THOUGH THE WHOLE MATED SHUTTLE SYSTEM MIGHT HAVE TO GO BACK TO THE VERTICAL ASSEMBLY BUILDING AND BE DISASSEMBLED TO PERFORM THE FIX. THAT WOULD HAVE MEANT A FURTHER LAUNCH DELAY OF UP TO TWO MONTHS.

BUT THE CAPABLE TEAM OF INDUSTRY AND NASA ENGINEERS, OF WHICH WE ARE RIGHTFULLY PROUD, CAME UP WITH A WHOLE SERIES OF IDEAS WHICH WERE SIFTED TO COME OUT WITH THE RIGHT ANSWERS. IN THE END WE WERE ABLE TO CERTIFY NOT ONE BUT TWO FIXES, EITHER ONE OF WHICH WOULD HAVE WORKED. THE FIRST ONE WE TRIED WORKED, AND IN HALF THE TIME THAT HAD BEEN PROJECTED, AND WE DIDN'T NEED THE SECOND. THE PEOPLE ON THE JOB KNEW EXACTLY WHAT THEY WERE DOING AND DID IT RIGHT.

THIS IS THE KIND OF HAPPENING THAT DEMONSTRATES EXCELLENCE AND THE IMPORTANCE OF TEAMWORK IN A DEVELOPMENT PROGRAM WHERE THE NORMAL COURSE OF EVENTS IS THE DISCOVERY OF PROBLEMS WHICH YOU SIMPLY SOLVE AND MOVE ON AHEAD.

YET THAT NOW EMINENTLY SUCCESSFUL PROGRAM WAS WIDELY CRITICIZED WHILE IN PROGRESS FOR DELAYS DUE TO NECESSARY FIXES, REDESIGNS, ALTERATIONS, AND CHANGES. WHAT THE CRITICS DID NOT UNDERSTAND, AND ONE OF THE THINGS I WOULD LIKE TO STRESS THIS MORNING, IS THAT DELAYS FOR JUST SUCH THINGS ARE ENDEMIC TO AND INHERENT IN ANY MAJOR DEVELOPMENT PROGRAM.

IT WAS FASHIONABLE WHILE THE SHUTTLE RECOVERY PROGRAM WAS IN PROGRESS TO POINT OUT THAT NASA HAD LOST ITS TECHNICAL TOUCH, THAT WE NO LONGER KNEW WHAT WE WERE DOING AS WE DID, FOR EXAMPLE, IN THE SO-CALLED SALAD DAYS OF SATURN/APOLLO. BUT THE FACT IS THAT, BECAUSE BOTH WERE DEVELOPMENT PROGRAMS, THEY WENT MUCH THE SAME WAY, WITH JUST ABOUT AS MANY DELAYS FOR FIXING THINGS AND GETTING THEM RIGHT, AS MANY ACCIDENTS, AS MANY GLITCHES, AVOIDABLE AND OTHERWISE, AS MANY PROBLEMS, GREAT AND SMALL, BEFORE FINAL SUCCESS WAS ACHIEVED.

LET ME TAKE JUST A FEW MINUTES TO DOCUMENT THAT STATEMENT, TO REMIND YOU THAT THE WAY TO THE MOON, LIKE THE COURSE OF THE SHUTTLE'S RETURN TO FLIGHT, WAS NOT WITHOUT ITS POT HOLES AND DETOURS.

SADLY, BOTH PROGRAMS HAD THEIR TRAGEDIES. WITH SATURN/APOLLO IT WAS THE FIRE OF JANUARY 27, 1967 THAT KILLED THREE ASTRONAUTS, RESULTED IN A RECOVERY PROGRAM MUCH LIKE THAT AFTER CHALLENGER REQUIRING SOME 1800 CHANGES TO THE SPACECRAFT SYSTEMS AND PROCEDURES, AND DELAYED THE FIRST MANNED FLIGHT, APOLLO 7, BY ABOUT TWENTY MONTHS.

IN A "WET TEST" PREPARATORY TO THE APOLLO 1 FLIGHT, PROBLEMS DEVELOPED IN THE NEW PROPELLANT SYSTEM WHEN HYDROGEN DID NOT FLOW BECAUSE OF FROZEN NITROGEN IN THE LINES. A FIX WAS DEVELOPED AND INSTALLED.

ON THE SAME MISSION, STATIC TEST FIRING OF THE S-IVB VEHICLE WAS DELAYED TEN DAYS BECAUSE OF A DIRTY FILTER IN THE GROUND OXIDIZER SYSTEM, AND WEEKLY REPORTS ON COMPUTER FAILURES RAN FIVE TO SIX PAGES LONG BECAUSE OF CRACKED SOLDER JOINTS AND THE FAILURE OF PROTECTIVE COATINGS ON CAPACITATORS.

ON THE UNMANNED LAUNCH OF APOLLO 1, THERE WAS CONSIDERABLE DAMAGE TO THE PAD WHEN A COUPLE OF FUSES VIBRATED LOOSE AND THE WATER DELUGE SYSTEM WAS INACTIVATED.

APOLLO 4 HAD ITS PROBLEMS TOO. DELIVERY OF THE SATURN II TO THE CAPE WAS DELAYED WHEN CRACKS WERE FOUND IN THE STAGE STRUCTURE; ON ARRIVAL THE TEST CREW FOUND DAMAGED RECIRCULATION PUMP CONNECTORS AND 22 CRACKED GUSSETS WHICH HAD TO BE REPLACED; AND ON A PRE-LAUNCH TEST IN OCTOBER OF 1967, A COMPUTER MONITORING THE LOADING OF PROPELLANTS FAILED, NECESSITATING THE REMOVAL OF ALMOST TWO MILLION LITERS OF FUEL.

APOLLO 7, ALREADY BADLY DELAYED FOR MODIFICATIONS AS A RESULT OF THE FATAL FIRE, SUFFERED ADDITIONAL DELAYS FOR SUCH MINOR, ANNOYING PROBLEMS AS THE INACCESSIBLITY OF THE POTABLE WATER DRAIN, AND NECESSARY MODIFICATIONS TO THE WASTE MANAGEMENT SYSTEM.

IN JANUARY, 1967, AN S-IVB STAGE UNDERGOING ACCEPTANCE TESTING BLEW UP BECAUSE OF THE USE OF THE WRONG WELDING MATERIAL IN A HELIUM STORAGE SPHERE OF THE J-2 ENGINE.

AND FINALLY I'M SURE MOST OF YOU REMEMBER THE HAIR-RAISING EPIC OF THE RETURN OF THE APOLLO 13 CREW IN APRIL OF 1970 AFTER A FAULTY LIQUID OXYGEN TANK CAUSED AN EXPLOSION IN THE SERVICE MODULE FIFTY-SIX HOURS ENROUTE TO THE MOON AND ALL POWER, OXYGEN, AND WATER SUPPLY WAS LOST IN THE SPACECRAFT.

OF COURSE I COULD GO ON MUCH LONGER SINCE APOLLO/SATURN, LIKE THE SHUTTLE RECOVERY, WAS A LONG-RUNNING AND COMPLEX PROGRAM INVOLVING HUNDREDS OF COMPANIES AND THOUSANDS OF SKILLED PEOPLE WORKING ON BOTH FLIGHT AND GROUND SYSTEMS AND PROCEDURES. BUT THE POINT ONCE AGAIN IS THAT THE IDENTIFICATION OF INEVITABLE PROBLEMS, THEIR SOLUTION BY TEAM EFFORT, AND RESULTANT CONTINUOUS PROGRESS UNTIL SUCCESS IS ACHIEVED, IS THE VERY NATURE OF ANY DEVELOPMENT PROGRAM. RELATIVE SUCCESS IN SUCH PROGRAMS IS MEASURED NOT BY LACK OF PROBLEMS BUT BY THE SKILL AND RAPIDITY BY WHICH THEY ARE IDENTIFIED AND SOLVED SO THAT PROGRESS CAN CONTINUE.

AND THANKS TO THE TRADITION OF EXCELLENCE THAT HAS BEEN BUILT UP IN AEROSPACE BY OUR GOVERNMENT/INDUSTRY TEAM, PROBLEMS, MAJOR AND MINOR, IN SUCH PROGRAMS AS THE TWO JUST DISCUSSED DO GET SOLVED, AND THE JOB GETS DONE TO THE GREAT BENEFIT OF OUR COUNTRY AND ITS PEOPLE.

BUT WE CAN DO BETTER.

WE STILL DO A LOT OF DUMB, AND COSTLY, AND DANGEROUS THINGS, AND WE MUST FIND A WAY TO PREVENT THAT.

ON THE FIRST SATURN 1B VEHICLE, SOMEONE LEFT A POLYETHELENE DUST CAP COVERING A VENT PORT IN THE STAGE FUEL TANK, AND AS A RESULT THE DOME OF THE TANK WAS INVERTED AND THE TANK HAD TO BE REPLACED.

ON APOLLO 6, WHEN THE #2 ENGINE IN THE S-II STAGE SHUT DOWN PREMATURELY, A WIRING ERROR CAUSED THE #3 ENGINE TO SHUT DOWN AS WELL.

ON APOLLO 13, 56 VOLTS WAS APPLIED TO THE 28-VOLT CIRCUIT FOR THE FUEL CELL CRYOGENIC TANKS-- AN ERROR THAT CONTRIBUTED TO THE EVENTUAL FAILURE OF THE TANK AND EXTREME DANGER TO THE CREW.

JUST THIS PAST SUMMER A SEAL ON A SOLID ROCKET BOOSTER BEING TESTED WAS OVER PRESSURIZED WHEN SOMEONE HOOKED UP A 1000 PSI AIR LINE INSTEAD OF THE CORRECT 100 PSI EQUIPMENT, AND AN IMPORTANT TEST WAS UNNECESSARILY DELAYED.

EARLY LAST AUGUST AN ENTIRE INSTRUMENT ASSEMBLY FOR THE SPACE TELESCOPE WAS DROPPED FROM A CRANE.

UNFORTUNATELY WE CANNOT SPECIFY CONTRACTUALLY THAT THERE WILL BE NO ACCIDENTS. BUT EXCELLENCE OF WORKMANSHIP MUST INCLUDE GETTING AWAY FROM SUCH COSTLY ERRORS TO THE MAXIMUM POSSIBLE EXTENT, STAYING RIGHT ON TOP OF THE PROBLEMS ALL THE TIME.

AND THERE IS ANOTHER WAY IN WHICH WE CAN DO BETTER. WE CAN GET AWAY FROM THE ALL-TOO-PREVALENT IDEA THAT YOU CAN ONLY GET MAXIMUM QUALITY WITH MAXIMUM EXPENDITURE.

OFTEN, ADMITTEDLY, IT IS UNAVOIDABLY NECESSARY TO PAY WELL FOR HIGH QUALITY. BUT JUST AS OFTEN, LET'S NOT FORGET, A SIMPLE, INEXPENSIVE WAY TO DO A JOB IS BEST. WE DON'T NEED STAINLESS STEEL PAPER CLIPS OR HIGH TECH CLOTHESPINS. WE DON'T HAVE TO POLISH THINGS ON ALL FOUR SIDES TO HAVE A QUALITY PRODUCT IF ONLY ONE SIDE DOES THE WORK.

I THINK THOSE ARE IMPORTANT THINGS TO KEEP IN MIND AS WE MOVE INTO A TREMENDOUSLY EXCITING FUTURE, WITH THE TRACKING AND DATA RELAY SATELLITE SYSTEM OR TDRSS UP THERE READY TO TRANSMIT DATA, AND A HUGE BACKLOG OF MAJOR SCIENCE PAYLOADS, AND ALWAYS THE CHALLENGE OF OUR BRIDGE TO THAT FUTURE AND ITS INDISPENSABLE CENTERPIECE--THE FREEDOM SPACE STATION.

SINCE THE APOLLO PROGRAM HAS COME UP SO OFTEN THIS MORNING, IT MIGHT BE INSTRUCTIVE TO LOOK BACK AND SEE HOW FAR WE HAVE COME IN THE FIELD OF SPACE SCIENCE SINCE THE FIRST LUNAR LANDINGS.

YOU WILL REMEMBER THAT THE FIRST FEW FLIGHTS WERE ALMOST ENTIRELY EXPLORATORY AND HAD LITTLE SCIENTIFIC EMPHASIS. BUT LATER MISSIONS INCLUDED A LOT MORE SCIENCE, CULMINATING WITH THE LANDING OF A PROFESSIOINAL GEOLOGIST, JACK SCHMITT, TO MAKE ON-THE-SPOT DIRECT OBSERVATIONS.

THEN, AFTER APOLLO, CAME SKYLAB AND A MAJOR SCIENCE BREAKTHROUGH, PARTICUALRLY IN THE FIELD OF SOLAR PHYSICS, WITH SO MUCH DATA COLLECTED, OF SUCH HIGH VALUE, IT IS STILL UNDER STUDY AND ANALYSIS ALL OVER THE WORLD.

THEN CAME THE PIONEERS, THE VOYAGERS, AND THE VIKINGS, AUTOMATED EXTENSIONS OF HUMAN INTELLIGENCE THAT HAVE GIVEN US THE FIRST CLOSE-UP LOOKS AT SEVEN OF THE NINE PLANETS IN OUR SYSTEM (VOYAGER II WILL FLY BY THE EIGHTH, NEPTUNE, NEXT YEAR). THE PIONEERS AND THE VOYAGERS ARE NOW ON THEIR WAY OUT OF THAT SYSTEM, THE FIRST MAN-MADE OBJECTS EVER TO ENTER INTER-STELLAR SPACE, STILL SENDING BACK THEIR PRICELESS DATA FROM BILLIONS OF MILES OUT THERE IN THE COSMIC DARK.

BUT THAT WAS ONLY THE BEGINNING. THE NEXT DECADE WILL SEE A WHOLE SERIES OF DRAMATIC AND IMPORTANT PLANETARY AND SOLAR MISSIONS, AND THE ORBITING OF GREAT NEW OBSERVATORIES, TENDED BY ASTRONAUTS FROM THE FREEDOM STATION AND THE SHUTTLE, THAT PROMISE TO ADD IMMEASURABLY TO THE KNOWLEDGE OF MANKIND.

PERHAPS THE MOST SCIENTIFICALLY EXCITING OF ALL IS THE HUBBLE SPACE TELESCOPE SCHEDULED FOR A SHUTTLE LAUNCH LATE NEXT SUMMER. THE HUBBLE IS THE MOST POWERFUL TELESCOPE EVER BUILT, AND FROM ORBIT ABOVE THE OBSCURING ATMOSPHERE WILL BE ABLE TO DISTINGUISH OBJECTS FIFTY TIMES DIMMER THAN THE DIMMEST WE CAN SEE TODAY, AND LOOK OUT IN DISTANCE AND BACK IN TIME NEARLY TO THE LIMITS OF THE UNIVERSE AND ALMOST TO THE PRIMAL "BIG BANG" ITSELF. WITH THIS MAGNIFICENT INSTRUMENT WE MAY BE ABLE TO OBSERVE DIRECTLY FOR THE FIRST TIME PLANETARY SYSTEMS LIKE OUR OWN IN ORBIT AROUND OTHER STARS. IT IS EVEN POSSIBLE THAT ASTRONOMERS CAN LEARN ENOUGH ABOUT THE MACRO-PROCESSES OF THE UNIVERSE TO RELATE THEM TO THE PARTICULAR PHYSICS OF THE ATOM, AND THUS FINALLY VALIDATE THE ELUSIVE THEORY OF THE UNIFIED FIELD.

BUT THERE IS MORE. MUCH MORE.

COMPLEMENTING THE OBSERVATIONS OF THE HUBBLE TELESCOPE WILL BE THE MAGELLAN HIGH RESOLUTION MAPPING MISSION TO VENUS; THE SIX-YEAR GALILEO ODYSSEY TO PROBE THE ATMOSPHERE AND STUDY THE CLOSE ENVIRONS OF JUPITER; THE EPIC ULYSSES FLIGHT ABOVE THE UNSEEN AND UNKNOWN POLES OF THE SUN; THE OBSERVER MISSION TO GIVE US THE DATA WE WILL NEED ON THE GEOLOGY AND CLIMATOLOGY OF MARS; AND THE ADVANCED X-RAY ASTROPHYSICS FACILITY, OR AXAF, WHICH WILL PROBE FOR ANSWERS TO SOME OF THE FUNDAMENTAL QUESTIONS IN PHYSICS AND ASTRONOMY.

IN OTHER WORDS, NOW THAT WE ARE ON THE MOVE AGAIN, THE PIPELINE IS FULL OF PROMISING AND URGENT SCIENTIFIC SPACE MISSIONS WITH THE POTENTIAL OF TRULY INESTIMABLE BENEFITS TO OUR COUNTRY AND ALL OF HUMANITY.

WHAT WILL BE NEEDED TO ACCOMPLISH THOSE AND OTHER VITAL PROGRAMS SUCCESSFULLY, TO GET THE URGENTLY NEEDED FREEDOM SPACE STATION UP AND MANNED ON SCHEDULE, AND TO KEEP THE MOMENTUM OF TECHNOLOGICAL SUCCESS ROLLING, IS JUST THE KIND OF HIGH QUALITY, HIGH PRODUCTIVITY, AND EXCELLENCE OF WORKMANSHIP THAT YOU HERE AND YOUR ASSOCIATES IN INDUSTRY AND GOVERNMENT ARE ABLE TO PROVIDE.

I KNOW AND EXPECT THAT YOU WILL COME THROUGH AGAIN., THAT YOU WILL FULFILL ONCE AGAIN YOUR COMMITMENT OF QUALITY TO THE FUTURE.

THANK YOU.

August 17, 1988

TALKING NOTES:

SCHEDULES AND PROBLEMS ASSOCIATED WITH THE SATURN APOLLO TIMEFRAME VERSUS CURRENT STS RECOVERY PROGRAM AND THE RELATIONSHIP OF THE CURRENT DEDICATED AND CAPABLE SPACE TEAM WITH THE DEDICATED AND CAPABLE SPACE TEAM OF THE APOLLO TIMEFRAME.

OUR CURRENT SPACE TEAM IS MADE UP OF THOUSANDS OF VERY SERIOUS AND DEDICATED PEOPLE FROM ALL WALKS OF LIFE AND ALL PARTS OF OUR COUNTRY. THE NASA PERSONNEL ARE EXTREMELY CAPABLE AND DEDICATED AS ARE THE THOUSANDS OF ENGINEERS, MANAGERS, TECHNICIANS, FACTORY WORKERS, SUPPLIERS OF RAW MATERIALS, ETC., WHICH MAKE UP OUR INDUSTRIAL COMMUNITY TEAM. OTHER AGENCIES ARE ALSO PART OF OUR DEDICATED TEAM AND DOD SPECIFICALLY IS PROVIDING EXCELLENT SUPPORT AT THE AGENCY LEVEL AND ALSO BY PROVIDING EXTREMELY CAPABLE PERSONNEL IN VARIOUS POSITIONS WITHIN NASA, IN MUCH THE SAME WAY AS DURING THE SATURN APOLLO PROGRAM.

THE SATURN APOLLO PROGRAM WAS AN EXTREMELY VISIBLE AND SUCCESSFUL PROGRAM, WITH A NATIONAL SPACE TEAM SIMILAR TO THE CAPABLE AND DEDICATED TEAM WE HAVE TODAY. THE SPACE TEAM DURING THE APOLLO TIMEFRAME HAD MANY SIMILAR PROBLEMS WITH COMPLEX EQUIPMENT, FACILITIES, GROUND SYSTEMS, FLIGHT SYSTEMS, PROCEDURES, ETC.,AS DOES OUR CURRENT TEAM. THE CHALLENGES WHICH THEY FACED INCLUDED SITUATIONS SUCH AS:

GROUND COMPUTERS WITH SOLDER CRACK PROBLEMS WHICH DELAYED TEST AND CHECKOUT (T&CO) OF FACILITIES AND FLIGHT VEHICLES, TWO TO THREE HOURS PER DAY FOR MONTHS. THOUSANDS OF PC CARDS WERE REWORKED AND REPLACED AS VITAL TESTS AND SCHEDULES WERE DELAYED.

ON THE FIRST SATURN IB VEHICLE, SA-201, THE SIB STAGE FUEL TANK BULKHEAD WAS INVERTED BECAUSE OF PROCEDURES WHICH PERMITTED A DUST CAP OVER A VENT PORT TO BE OVER LOOKED. AS A RESULT OF THE ACCIDENT, THE TANK WAS CHANGED OUT ON THE LAUNCH PAD AND THE VEHICLE FLEW SUCCESSFULLY

WITHIN THE COMPLEX CIRCUITRY OF THE FLIGHT HARDWARE, SNEAK CIRCUITS WERE CONTINUOUSLY BEING FOUND AND CORRECTED FOR EACH FLIGHT. MANY OF THESE SNEAK CIRCUITS COULD HAVE CAUSED DISASTERS ON ANY OF THE FLIGHTS HAD CERTAIN SEQUENCE OF EVENTS OCCURRED. BLOCKING DIODES WERE STILL BEING INSTALLED AS A REMEDY FOR THESE PROBLEMS, RIGHT UP TO THE LAST FLIGHT OF THE SATURN FLEET.

IN ONE INSTANCE, 56 VOLTS WAS APPLIED TO THE 28 VOLT CIRCUIT FOR THE HEATERS IN THE FUEL CELL CRYO TANKS. THE APOLLO 13 MISSION WAS ABORTED AND THE CREW NARROWLY ESCAPED INJURY AND WERE RETURNED TO EARTH BY SUPERIOR EFFORT PUT FORTH BY THE TOTAL TEAM.

ON APOLLO 6, THE S-II STAGE ENGINE #2 SHUT DOWN PREMATURELY. A MISWIRING (ERROR) EXISTED SUCH THAT COMMANDS FOR ENGINE #2 AND ENGINE #3 WERE INTERCHANGED AND SUBSEQUENTLY ENGINE #3 SHUT DOWN.

POGO PROBLEMS EXISTED IN FLIGHT IN THE S-IC STAGE OF APOLLO V AND A FIX WAS DESIGNED AND INSTALLED FOR THE NEXT FLIGHT.

SOLDER BALL PROBLEMS EXISTED WITH TRANSISTORS AND CONTAMINANTS WERE A PROBLEM WITH RELAYS.

- FAILURE OF THE FLIGHT CONTROL COMPUTER AT KSC WAS A PREVALENT PROBLEM WITH CHANGEOUT AND SUPPORTING LOGISTICS A CONTINUOUS HEADACHE.

- THE FIRE ON SA-204 WAS A MAJOR SET BACK AND THE RECOVERY SCHEDULE CONTAINED MANY SIMILAR PROBLEMS AS OUR TEAM HAS HAD WITH STS-26R.

REFLECTING ON SOME SPECIFIC PROBLEMS AS RELATED TO THE SCHEDULES DURING THE APOLLO PROGRAM BOTH PRIOR AND POST APOLLO FIRE TIMEFRAME ARE....

SEE ATTACHED FACT SHEETS.

Schedule Impact of the AS-204 Accident

The AS-204 accident occurred on January 27, 1967.

As a direct result of the accident, the command module under went major design changes that delayed the first manned Apollo launch approximately 20 months (February 1967 to October 1968).

However, the true impact to the Apollo schedule was masked by rescheduling and elimination of Apollo launches.

- Instead of two manned Saturn 1B launches there was only one.
- Instead of three unmanned Saturn-V launches there were only two.

As a result, the Lunar Landing occurred only 7-9 months later (July 16, 1969 vs. late 1968) than originally planned prior to the AS-204 accident.

Apollo Schedule up to and including the AS-204 Accident (CSM-012 Fire)

- AS-201 (CSM-009)	unmanned	Launched February 26, 1966.
- AS-202 (CSM-011)	unmanned	Launched August 25, 1966.
- AS-203 (Hydrogen Study)	unmanned	Launched July 5, 1966.
- AS-204 (CSM-012)	First manned Apollo flight, accident occurred Jan 17, 1967. Prior to accident, planned launch date slipped from December 1966 to February 1967 due to late delivery of CSM-012.	
- AS-501		Scheduled May 1967.
- First Lunar Landing		Scheduled Late 1968.

Schedule Impact of the AS-204 Accident (cont)

Apollo Schedule After AS-204 Accident

- Apollo-4 unmanned (AS-501, CSM-017, and LM-10R	Launch November 9, 1967 (6 months later than previously planned
- Apollo-5 unmanned (SA-204 and LM-1)	Launch January 22, 1968
- Apollo-6 unmanned (AS-502, CSM-020, and LM-2R)	Launch April 4, 1968
- Apollo-7 manned (SA-205 and CSM-101)	Launch October 11, 1968 (20 months later than previously planned
- Apollo-8 manned (AS-503, CSM-103, and LMB)	Launch December 21, 1968 (Lunar Orbit)
- Apollo-9 manned (AS-504, CSM-104, LM-3	Launched March 3, 1969 (Manned test of Lunar hardware in earth orbit)
- Apollo-10 manned (AS-505, CSM-106, LM-4)	Launched May 18, 1969 (Manned test of Lunar hardware near Moon)
- Apollo-11 (AS-506, CSM-107, LM-5)	Launched July 16, 1969 Lunar Landing - occurred 7-9 months later than previously planned (AS-204 accident)

APOLLO 1 MISSION
(AS-201 & CSM-009)

On August 18, 1965 - Erection of flight S-1B stage and dummy S-IVB stage and Instrument Unit (IU) marked start of launch complex, LC-34 facility tests.

KSC RCA-110A Computer breakdowns during the ground equipment tests caused day for day slips in schedule.

Delays in MSFC Breadboard Testing of RCA 110A operating programs.

Wet Test in September 1965, identified problems in the new propellant system. (Hydrogen did not flow - frozen nitrogen in the fuel line.)

Replacement of an S-1B Stage Fuel Tank - Tank was damaged during tanking test. A polyethelane cover (dust cap) was inadvertently left over a vent port and the dome of the tank was inverted. Repressurisation left wrinkles. The tank was subjected to above normal pressures without mishap. MSFC wanted it replaced. Delayed S-IV B stage erection by two days, but numerous breakdowns in the RCA 110A computer had already thrown the tests 12 days behind schedule (Reference Hans Gruene Weekly Notes, September 17, 24 and October 1, and Petrone October 7, 1965).

By mid-September 1965 Preston and Petrone set 201 launch date for late January 1966.

Mueller wanted to launch in December 1965 - However delays in spacecraft delivery precluded a 1965 launch.

Marshall's breadboard and software delivery to the Cape was delayed until November 1, 1965.

October 15, 1965, Pad ops at a standstill resulting from lack of software. Computer could not apply power to the launch vehicle.

By the end of the month KSC started testing with an uncertified program tape.

Flight Instrument Unit (IU) arrived end of October and had an ECS coolant pump problem.

APOLLO 1 MISSION
(AS-201 & CSM-009)

October 25, IU stacked on S-IVB

CM-009 On-dock at KSC in late October, 1965.

November 9, 1965 - Static firing delayed 10 days due to dirty filter in ground oxidizer system.

November 10, 1965, increasing problems with the RCA 110A. Protective coated capacitors failures and cracked solder joints resulted in change out of PC boards in the Blockhouse and launch pad computers.

November 24, 1965 - Failure of the first computer run tests--Switch Selector and Emergency Detector System Test.

December 3, 1965, High speed memory parity errors (caused by cracked solder joint problems) occurred causing random computer outputs operating the switch selector. KSC (Rigell) requested outside support for RCA-110 computer problem.

- After five (5) successive Switch selector Tests - only partial success.
- December 15, 1965 defective RCA-110 circuit board found. Launch Vehicle Operations (LVO) began survey of all boards. IB launch vehicle checkout was 16 days behind schedule. The space craft showed a 20 day slip.
- January 12, 1966 - New 201 schedule moved launch date to February 6, 1966.
- Weekly reports on computer failures ran five to six pages long. KSC Instrument Unit Stage Manager was directed by Dr. Mueller to send daily Twx to Dr. Mueller relative to number of parity errors, hours of test and check out (T&CO) time lost, and cause of problems.
- Computer problems with ACE and the 110A caused 13 hour hold on January 24.

APOLLO 1 MISSION
(AS-201 & CSM-009)

- On February 1, 1966 launch date was moved to February 22 1966.
- Began countdown February 20--bad weather caused 2 day hold.
- February 26, 1966 - AS-201 launched.
- Pad experienced considerable damage--3 seconds after lift-off two fuses vibrated loose and blew a 300 amp power feed, LC 34 pad lost power, no water deluge system.
- In the 20 months between AS-201 and AS-501, the major ground computer (RCA 110A) problems were resolved with essentially total PC board change out. Boards were recycled to manufacturer where divits were used to correct soldering problem. February 1966 - November 1967

1-2-1

APOLLO 4 MISSION
(Launch of AS-501)

In mid-1966, General Phillips hoped to launch the first Saturn V early in 1967 (February). However, the S-II stage delivery to KSC, a pacing item, was delayed from July to October 1966.

Early in the AS-501 checkout, August 19, 1966, an LC-39 LOX line ruptured and caused a 45 day delay.

The S-II delivery to KSC was delayed when a technician at Michoud on August 16, 1966, found cracks in stage structure. Discovery delayed acceptance firing. New date for delivery to KSC was January 9, 1967, with scheduled launch 3 months away (April 1967).

Proceeded with AS-501 checkout without S-II (used spacer).

CSM-017 arrived at KSC on December 24, 1966, and was mated to the launch vehicle January 12, 1967. S-II stage arrived at KSC on January 21, 1967, 11 days late from revised schedule.

S-II test crew found damaged connectors on the recirculation pumps and 22 cracked gussets. The gussets supported the horizontal ribs of the stage. They had to be replaced.

Despite the delay with the S-II stage, KSC still expected to meet the new launch date of May 1967.

CSM-012 fire on AS-204 occurred on January 27, 1967.

February 14, 1967 - CSM-017 was removed from AS-501 for inspection. By March 1 inspectors found so many wiring errors that restacking was cancelled. Modifications and repair work continued into June.

The S-II stage was erected on February 23, 1967.

On May 24, 1967 the S-II stage was removed for inspection because of cracks found in the propellant tank weld seams on another S-II stage at the factory in California. Estimated impact was a week to 10 days.

APOLLO 4 MISSION
(Launch of AS-501)

Mid-June - S-II stage completed and restacked.

June 20, 1967 - CSM-017 was mated to AS-501.

August 26, 1967 - AS-501 rolled out of the VAB, six months after original scheduled launch date.

On August 31, 1967, KSC issued a new schedule. In less than a week it was changed when Boeing had to replace the hydraulic engine activators On the S-1C stage.

AS-501 malfunction test was scrubbed because of high winds and rain.

Six (6) day countdown test started September 27, 1967.

Following a hold, the test went smoothly from T-18 to T-13 hours when a computer problem caused another delay.

October 4, 1967, countdown reached T-45 minutes when a computer monitoring the propellant loading operation failed. As a result 1,900,000 liters of RP-1 and liquid oxygen had to be removed from the S-1C stage.

Count was resumed on October 9, 1967, more computer problems and faulty regulator on the helium gas marred operations that day. When the countdown reached T-5 hours a two (2) day recess was called (launch team exhausted).

October 11, 1967 - Battery heater problem on S-II stage caused another days delay.

October 13, 1967 - KSC completed countdown test and a new launch date of November 7, 1967 was set.

Flight Readiness Review was on October 19, 1967.

By October 20 KSC was 2 days behind schedule.

November 6, 1967 countdown started.

November 9, 1967 - AS-501 Launched.

After launch, Mueller predicted that it would be possible to land on the moon about mid-1969 (approximately 7-8 months from original plan prior to AS-204 accident).

APOLLO 7 FIRST MANNED MISSION
(AS-205 & CSM 101)

Apollo 7 - First manned Apollo mission was the last Saturn 1B flight in the Apollo Program.

Originally scheduled for late 1966, and then 1967 was again rescheduled to March 1968 because of January 27, 1967 fire on AS-204.

October 1967 Apollo Program Office rescheduled mission to October 1968 (provided the Lunar Module Test on Apollo 5 goes well).

KSC planned to stack the spacecraft, rescheduled as a result of the AS-204 accident, for July 19, 1968 and launch mid-September, 1968.

Because of extensive modifications, spacecraft could not meet the schedule and arrived at KSC on May 30, 1968 more than two months late. There were some 1,800 changes to systems and procedures.

Major spacecraft changes included: Quick opening hatch, elimination of combustible material and re-routing of wire bundles.

Major Problems that occurred after KSC processing began (May 1968) included:

- 6/13/68 — Problems were encountered with the SM to CM umbilical buildup. Assembly and use of the associated tooling jigs caused schedule slippage. In addition, reverse installation of two end plates installed at Downey and leaks in the H_2O line which had to be replaced contributed to the slippage.

- 6/24/68 — Various small problems were encountered during the ECS portion of the Combined Systems Test. Delays were experienced because of inaccessibility of the drain port of the portable water tank, leakage in the suit loop, and a modification to the waste management system.

APOLLO 7 FIRST MANNED MISSION
(AS-205 & CSM 101)

- 7/12/68 — The S-band amplifier developed a low power circuit and was replaced with a new unit from Downey. The unit from Downey had unacceptable power fluctuations and was replaced with a unit from Collins Radio.

- 7/16/68 — The unmanned Altitude Test was postponed due to problems encountered with Pulse Code Modulator (PCM) drop-out (telemetry failure, loss of signals) when chamber altitude reached 24,000 feet. The PCM drop-out was isolated to the vacuum-ion pumps on the cryogenic tanks in the Service Module. Fuses were pulled to eliminate the circuit from the system.

- 7/18/68 — Other delays were encountered when MSC (now JSC) directed that the Potable Water System be deserviced and refilled with unchlorinated water.

Due to extensive spacecraft testing on August 1, 1968, KSC revised the Apollo 7 schedule for spacecraft erection August 10, 1968 and launch would then be planned to occur October 9, 1968.

On September 14, 1968, CDDT was slipped one day due to problems encountered with GSE during cryo servicing. LH_2 servicing was attempted but was not accomplished.

No serious delays in last 10 weeks of processing and launch occurred on October 11, 1968, approximately 20 months later than initially planned.

1/20/67

S-IVB Stage Blow Up

- S-IVB-503 stage was in test stand at Sacramento under going acceptance testing.
- 150 seconds into simulated mission, prior to stage ignition, the stage countdown was aborted because of a faulty computer tape mechanism. Problem fixed test resumed.
- Eleven seconds before simulated lift off occurred, the stage exploded.
- Source of explosion was traced to one of the eight ambient - temperature helium storage spheres located on the thrust structure of the J-2 engine.
- Exploding sphere ruptured the propellant fill line, allowing liquid oxygen and liquid hydrogen to mix and ignite, setting the explosion.
- Analyses showed that the sphere had been welded with pure titanium weld material rather than the alloy material specified.
- The helium sphere and weld seam had been tested to withstand extremely high over pressures but repeated tests weakened the sphere and resulted in disintegration and destruction of the stage.
- Replacement spheres were built in-house by MDAC. Welding specs changed and quality control procedures enhanced.
- Loss of S-IVB-503 illustrated the ever present probability of human-error.

APOLLO 6 AS-502 S-II STAGE ENGINE MALFUNCTION

- At 319 second engine No. 2 exhibited a performance shift.

- Engine continued reduced performance until 412.3 seconds.

- At 412.92 seconds engine No. 2 cut off and at 414.18 seconds engine No. 3 also cut off.

- Engine No. 2 Augmented Spark Igniter (ASI) fuel line failure ultimately caused engine failure.

- Testing revealed that an oxidizer rich mixture, caused by a fuel leak, creates very high temperature and rapidly erodes the injectors and because of this erosion the LOX dome of engine No. 2 eventually failed, opening the LOX high pressure system and causing engine cut off (ECO).

- Interchanged LOX prevalve control wiring connections (wired wrong) between engines No. 2 & 3 solenoids caused the premature cut off of engine No. 3.

SATURN 1B First Stage Turbine Blade Problem

- During test firing, on a Saturn 1B first stage, one H-1 engine experienced failure of turbine blades.
- Defective blades were found to have been cast from 316 stainless steel rather than the stellite 21 material specified.
- An error at Haynes Stellite created the mix-vp.
- Quality control procedures could not catch this type of mistake.
- The turbine blade problem not only compromised the Apollo-Saturn program, it shadowed the capability of the national defense.
- Haynes Stellite came up with an "eddy current" machine that could differentiate between Stellite 21 material and the undesirable 316 stainless steel.
- 10 engines were identified with alien turbine blades.
- Hence forth - every blade manufactured was tested for hardness and were subjected to a wider array of metallurgical tests.
- H-1 engines experienced one serious problem in 15 launches of Saturn 1 & Saturn 1B (SA-6). Incident was not entirely unexpected, an improved power train design had been designed - new units were already installed on SA-7.

APOLLO 13 MISSION
(AS-503, CSM 109 & LM 7)

The launch vehicle, AS-503 arrived at KSC in June 1969 for a March 1970 launch. The Apollo 13 mission was planned as a Lunar landing mission.

On March 24, 1970 the launch crew finished loading the cryogenics into the service module. When the crew partially emptied the two liquid oxygen tanks, the first tank performed normally emptying half of its content but the second tank released only 8% of its LOX.

The spacecraft team resumed detanking operations on the 27th after discussing the problem with Houston, Downey & Beech Aircraft. After additional attempts at higher pressure proved unsuccessful, the KSC Team decided to "Boil off" the remaining LOX. The Tank heaters, energized by 56 volts of direct current, were turned on; 90 minutes later the tank fans were also activated. After eight hours of heating and venting, the tank emptied.

On March 30, 1970 KSC undertook a partial fill. Both tanks reached 20% level without trouble, but emptying the second tank required heating and cycling. (The problem appeared to be a possible leak between the fill line and the quantity probe because of a loose fit in the sleeves and tube.

Apollo technical and management personnel reviewed the possible hazards of flying with a loose fill tube against the problem of replacement. The decision was to keep the defective tank.

Apollo 13 countdown proceeded without major incident, and lift-off came at 2:13 p.m. on April 11, 1970.

Apollo 13 Mission Summary:

The S-11 stage center engine shut down approximately 132 seconds early due to low frequency oscillations (14 to 16 hertz) experienced on the S-II stage. To compensate for the early center engine cutoff the remaining four engines burned longer than initially planned and the S-IVB orbital insertion burn was approximately 9 seconds longer than predicted. The TLI burn was nominal

The mission was aborted enroute to the moon after about 56 hours of flight due to loss of service module cryogenic oxygen and consequent loss of capability to generate electrical power, to provide oxygen and to produce water in the command/service module.

Spacecraft systems performance was nominal until 55:53:18 GET. About 2 seconds after energizing the fan circuit, a short was indicated in the current from fuel cell 3, which was supplying power to cryogenic oxygen tank 2 fans. Within several seconds, two other shorted conditions occurred.

Electrical shorts in the fan circuit ignited the wire insulation, causing temperature and pressure increases within the tank. When the pressure reached the tank relief valve full-flow conditions, the pressure began decreasing for about 9 seconds.

The next series of events occurred within a fraction of second. A tank line in the vacuum jacket pressurizing the annulus burst, because of heat, and in turn, caused the blow-out plug on the vacuum jacket to rupture. A rapid pressure rise in SM bay resulted in separation of the outer panel. The panel struck one of the dishes of the high-grain antenna. Data was lost for about 1.8 seconds as the high-gain antenna switched from narrow beam to wide beam because of the antenna being hit and damaged.

Following recovery of the data, cryogenic oxygen tank 2 pressure indication was at the lower limit readout valve. the cryogenic oxygen tank 1 heaters were on, and the tank 1 pressure was decaying rapidly.

Fuel cells 1 and 3 operated for about 2 1/2 minutes after the reactant valves closed. Fuel cell 2 was turned off about 2 hours later because of the loss of pressure from cryogenic oxygen tank 1.

As a result of these occurrences, the CM was powered down at approximately 58:40 GET and IM was configured to supply the necessary power and other consumables.

The first maneuver following the incident was made with the descent propulsion system at approximately 61:30 GET and placed the spacecraft once again on a free-return trajectory. A maneuver that was performed with the descent engine 2 hours after passing pericynthion reduced the transearth transit time and moved the earth landing point to the South Pacific. Two small transearth midcourse corrections were required prior to entry; the first using descent propulsion system and the second using the lunar module reaction control system.

All LM systems performed satisfactorily in providing the necessary power and environmental control to the spacecraft. The requirement for lithium hydroxide to remove carbon dioxide from the spacecraft atmosphere was met by combination of CM and LM cartridges since the LM cartridges alone would not satisfy the total requirement. The crewmen, with direction from Mission Control, built an adapter for the CM cartridges to accept the LM hoses.

The service module was jettisoned at approximately 138 hours GET, and the crew observed and photographed the bay-4 area and remarked that the outer skin covering bay-4 had been severely damaged, with a large portion missing. The lunar module was jettisoned about 1 hour before entry, which was performed nominally using the primary guidance and navigation system.